

КАЗАНСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ

# Задачи по дискретной математике для контрольных и самостоятельных работ

О.-д. функции. Теория кодирования. Графы

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Практикум предназначен для студентов, изучающих курс “Дискретная математика”, а также для преподавателей, ведущих практические занятия по данному курсу.

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1. Построить диаграмму Мура для о.д.-функции  $\varphi(x(1)x(2)\dots x(t)\dots) = y(1)y(1)\dots y(t)\dots$ , где

$$1.1. y(t) = \begin{cases} 0, & t = 1 \\ x(t-1) \sim x(t), & t \geq 2 \end{cases}$$

$$1.2. y(t) = \begin{cases} 1, & t = 1 \\ x(t-1) \oplus x(t), & t \geq 2 \end{cases}$$

$$1.3. y(t) = \begin{cases} 0, & t = 1 \\ x(t-1)x(t), & t \geq 2 \end{cases}$$

$$1.4. y(t) = \begin{cases} 0, & t = 1 \\ x(t) \rightarrow x(t-1), & t \geq 2 \end{cases}$$

$$1.5. y(t) = \begin{cases} 1, & t = 1 \\ x(t) \mid x(t-1), & t \geq 2 \end{cases}$$

$$1.6. y(t) = \begin{cases} 0, & t = 1 \\ x(t-1) \vee x(t), & t \geq 2 \end{cases}$$

$$1.7. y(t) = \begin{cases} 0, & t = 1 \\ x(t-1) \rightarrow x(t), & t \geq 2 \end{cases}$$

$$1.8. y(t) = \begin{cases} 1, & t = 1 \\ x(t-1) \downarrow x(t), & t \geq 2 \end{cases}$$

$$1.9. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t-1)} \rightarrow x(t), & t \geq 2 \end{cases}$$

$$1.10. y(t) = \begin{cases} 1, & t = 1 \\ \overline{x(t-1) \vee x(t)}, & t \geq 2 \end{cases}$$

$$1.11. y(t) = \begin{cases} 1, & t = 1 \\ x(t-1) \oplus \overline{x(t)}, & t \geq 2 \end{cases}$$

$$1.12. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t-1)} \sim x(t), & t \geq 2 \end{cases}$$

$$1.13. y(t) = \begin{cases} 1, & t = 1 \\ x(t-1) \rightarrow \overline{x(t)}, & t \geq 2 \end{cases}$$

$$1.14. y(t) = \begin{cases} 1, & t = 1 \\ \overline{x(t)} \sim \overline{x(t-1)}, & t \geq 2 \end{cases}$$

$$1.15. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t)x(t-1)}, & t \geq 2 \end{cases}$$

$$1.16. y(t) = \begin{cases} 1, & t = 1 \\ \overline{x(t-1) \rightarrow x(t)}, & t \geq 2 \end{cases}$$

$$1.17. y(t) = \begin{cases} 1, & t = 1 \\ \overline{x(t)} \oplus \overline{x(t-1)}, & t \geq 2 \end{cases}$$

$$1.18. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t-1)} \downarrow x(t), & t \geq 2 \end{cases}$$

$$1.19. y(t) = \begin{cases} 0, & t = 1 \\ x(t-1)\overline{x(t)}, & t \geq 2 \end{cases}$$

$$1.20. y(t) = \begin{cases} 1, & t = 1 \\ \overline{x(t-1)} \vee x(t), & t \geq 2 \end{cases}$$

$$1.21. y(t) = \begin{cases} 0, & t = 1 \\ x(t) \oplus \overline{x(t-1)}, & t \geq 2 \end{cases}$$

$$1.22. y(t) = \begin{cases} 0, & t = 1 \\ x(t) \mid \overline{x(t-1)}, & t \geq 2 \end{cases}$$

$$1.23. y(t) = \begin{cases} 1, & t = 1 \\ x(t-1) \vee \overline{x(t)}, & t \geq 2 \end{cases}$$

$$1.24. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t)} \mid x(t-1), & t \geq 2 \end{cases}$$

$$1.25. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t)} \mid x(t-1), & t \geq 2 \end{cases}$$

$$1.26. y(t) = \begin{cases} 1, & t = 1 \\ x(t-1)\overline{x(t)}, & t \geq 2 \end{cases}$$

$$1.27. y(t) = \begin{cases} 0, & t = 1 \\ x(t) \downarrow \overline{x(t-1)}, & t \geq 2 \end{cases}$$

$$1.28. y(t) = \begin{cases} 0, & t = 1 \\ x(t-1) \sim \overline{x(t)}, & t \geq 2 \end{cases}$$

$$1.29. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t-1)} \oplus x(t), & t \geq 2 \end{cases}$$

$$1.30. y(t) = \begin{cases} 1, & t = 1 \\ \overline{x(t-1)} \rightarrow x(t), & t \geq 2 \end{cases}$$

2. Построить систему канонических уравнений для о.д.-функции  $\varphi(x(1)x(2)\dots x(t)\dots) = y(1)y(1)\dots y(t)\dots$ , где

$$2.1. y(t) = \begin{cases} 0, & t = 1 \\ y(t-1) \sim x(t), & t \geq 2 \end{cases}$$

$$2.2. y(t) = \begin{cases} 1, & t = 1 \\ y(t-1) \oplus x(t), & t \geq 2 \end{cases}$$

$$2.3. y(t) = \begin{cases} 1, & t = 1 \\ y(t-1)x(t), & t \geq 2 \end{cases}$$

$$2.4. y(t) = \begin{cases} 0, & t = 1 \\ x(t) \rightarrow y(t-1), & t \geq 2 \end{cases}$$

$$2.5. y(t) = \begin{cases} 1, & t = 1 \\ x(t) \mid y(t-1), & t \geq 2 \end{cases}$$

$$2.6. y(t) = \begin{cases} 0, & t = 1 \\ y(t-1) \vee x(t), & t \geq 2 \end{cases}$$

$$2.7. y(t) = \begin{cases} 0, & t = 1 \\ y(t-1) \rightarrow x(t), & t \geq 2 \end{cases}$$

$$2.8. y(t) = \begin{cases} 1, & t = 1 \\ y(t-1) \downarrow x(t), & t \geq 2 \end{cases}$$

$$2.9. y(t) = \begin{cases} 0, & t = 1 \\ \overline{y(t-1)} \rightarrow x(t), & t \geq 2 \end{cases}$$

$$2.10. y(t) = \begin{cases} 1, & t = 1 \\ \overline{y(t-1) \vee x(t)}, & t \geq 2 \end{cases}$$

$$2.11. y(t) = \begin{cases} 1, & t = 1 \\ y(t-1) \oplus \overline{x(t)}, & t \geq 2 \end{cases}$$

$$2.12. y(t) = \begin{cases} 0, & t = 1 \\ \overline{y(t-1)} \sim x(t), & t \geq 2 \end{cases}$$

$$2.13. y(t) = \begin{cases} 1, & t = 1 \\ y(t-1) \rightarrow \overline{x(t)}, & t \geq 2 \end{cases}$$

$$2.14. y(t) = \begin{cases} 1, & t = 1 \\ \overline{x(t)} \sim \overline{y(t-1)}, & t \geq 2 \end{cases}$$

$$2.15. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t)y(t-1)}, & t \geq 2 \end{cases}$$

$$2.16. y(t) = \begin{cases} 1, & t = 1 \\ \overline{y(t-1) \rightarrow x(t)}, & t \geq 2 \end{cases}$$

$$2.17. y(t) = \begin{cases} 1, & t = 1 \\ \overline{x(t) \oplus y(t-1)}, & t \geq 2 \end{cases}$$

$$2.18. y(t) = \begin{cases} 0, & t = 1 \\ \overline{y(t-1) \downarrow x(t)}, & t \geq 2 \end{cases}$$

$$2.19. y(t) = \begin{cases} 1, & t = 1 \\ \overline{y(t-1)x(t)}, & t \geq 2 \end{cases}$$

$$2.20. y(t) = \begin{cases} 1, & t = 1 \\ \overline{y(t-1) \vee x(t)}, & t \geq 2 \end{cases}$$

$$2.21. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t) \oplus y(t-1)}, & t \geq 2 \end{cases}$$

$$2.22. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t) \mid y(t-1)}, & t \geq 2 \end{cases}$$

$$2.23. y(t) = \begin{cases} 0, & t = 1 \\ \overline{y(t-1) \vee x(t)}, & t \geq 2 \end{cases}$$

$$2.24. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t) \mid y(t-1)}, & t \geq 2 \end{cases}$$

$$2.25. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t) \mid y(t-1)}, & t \geq 2 \end{cases}$$

$$2.26. y(t) = \begin{cases} 1, & t = 1 \\ \overline{y(t-1)x(t)}, & t \geq 2 \end{cases}$$

$$2.27. y(t) = \begin{cases} 0, & t = 1 \\ \overline{x(t) \downarrow y(t-1)}, & t \geq 2 \end{cases}$$

$$2.28. y(t) = \begin{cases} 0, & t = 1 \\ \overline{y(t-1) \sim x(t)}, & t \geq 2 \end{cases}$$

$$2.29. y(t) = \begin{cases} 0, & t = 1 \\ \overline{y(t-1) \oplus x(t)}, & t \geq 2 \end{cases}$$

$$2.30. y(t) = \begin{cases} 0, & t = 1 \\ \overline{y(t-1) \rightarrow x(t)}, & t \geq 2 \end{cases}$$

3. Построить диаграмму Мура для о.д.-функции  $\varphi(x(1)x(2)\dots x(t)\dots) = y(1)y(1)\dots y(t)\dots$ , где

$$3.1. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ \overline{x(t-1) \oplus x(t-2)}, & t \geq 3 \end{cases}$$

$$3.2. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ x(t-1) \vee \overline{x(t-2)}, & t \geq 3 \end{cases}$$

$$3.3. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ \overline{x(t-1)} \sim x(t-2), & t \geq 3 \end{cases}$$

$$3.4. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ x(t-1) \rightarrow \overline{x(t-2)}, & t \geq 3 \end{cases}$$

$$3.5. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ \overline{x(t-2)} \sim x(t-1), & t \geq 3 \end{cases}$$

$$3.6. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ \overline{x(t-2)x(t-1)}, & t \geq 3 \end{cases}$$

$$3.7. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ \overline{x(t-1) \rightarrow x(t-2)}, & t \geq 3 \end{cases}$$

$$3.8. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ \overline{x(t-2) \vee x(t-1)}, & t \geq 3 \end{cases}$$

$$3.9. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ \overline{x(t-1) \mid x(t-2)}, & t \geq 3 \end{cases}$$

$$3.10. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ x(t-1)\overline{x(t-2)}, & t \geq 3 \end{cases}$$

$$3.11. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ \overline{x(t-1)} \rightarrow x(t-2), & t \geq 3 \end{cases}$$

$$3.12. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ x(t-1) \mid \overline{x(t-2)}, & t \geq 3 \end{cases}$$

$$3.13. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ x(t-1) \mid x(t-2), & t \geq 3 \end{cases}$$

$$3.14. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ \overline{x(t-1)} \rightarrow \overline{x(t-2)}, & t \geq 3 \end{cases}$$

$$3.15. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ \overline{x(t-2)} \downarrow x(t-1), & t \geq 3 \end{cases}$$

$$3.16. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ \overline{x(t-2)} \downarrow x(t-1), & t \geq 3 \end{cases}$$

$$3.17. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ \overline{x(t-1)} \overline{x(t-2)}, & t \geq 3 \end{cases}$$

$$3.18. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ x(t-2) \downarrow \overline{x(t-1)}, & t \geq 3 \end{cases}$$

$$3.19. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ x(t-1) \oplus \overline{x(t-2)}, & t \geq 3 \end{cases}$$

$$3.20. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ x(t-1) \sim x(t-2), & t \geq 3 \end{cases}$$

$$3.21. y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ x(t-1) \vee x(t-2), & t \geq 3 \end{cases}$$

$$3.22. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ x(t-1)x(t-2), & t \geq 3 \end{cases}$$

$$3.23. y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ x(t-2) \rightarrow x(t-1), & t \geq 3 \end{cases}$$



$$3.24. \ y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ x(t-2) \downarrow x(t-1), & t \geq 3 \end{cases}$$

$$3.25. \ y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ x(t-1) \oplus x(t-2), & t \geq 3 \end{cases}$$

$$3.26. \ y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ \overline{x(t-1)} \downarrow \overline{x(t-2)}, & t \geq 3 \end{cases}$$

$$3.27. \ y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ x(t-2) \mid \overline{x(t-1)}, & t \geq 3 \end{cases}$$

$$3.28. \ y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ x(t-1) \sim \overline{x(t-2)}, & t \geq 3 \end{cases}$$

$$3.29. \ y(t) = \begin{cases} 0, & t = 1 \\ 1, & t = 2 \\ \overline{x(t-1)} \vee x(t-2), & t \geq 3 \end{cases}$$

$$3.30. \ y(t) = \begin{cases} 1, & t = 1 \\ 0, & t = 2 \\ \overline{x(t-1)} \rightarrow x(t-2), & t \geq 3 \end{cases}$$

4. Для о.д.-функции  $\varphi$ , заданной системой канонических уравнений, построить усеченное дерево.

$$4.1. \varphi : \begin{cases} y(t) = x_1(t) \sim x_2(t) \sim q(t-1) \\ q(t) = x_1(t) \oplus x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.2. \varphi : \begin{cases} y(t) = x_1(t) \vee x_2(t) \vee q(t-1) \\ q(t) = x_1(t) \oplus x_2(t) \\ q(0) = 1 \end{cases}$$

$$4.3. \varphi : \begin{cases} y(t) = x_1(t) \oplus x_2(t) \oplus q(t-1) \\ q(t) = x_1(t)x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.4. \varphi : \begin{cases} y(t) = (x_1(t) \rightarrow x_2(t)) \rightarrow q(t-1) \\ q(t) = x_1(t) \oplus x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.5. \varphi : \begin{cases} y(t) = x_1(t)x_2(t)q(t-1) \\ q(t) = x_1(t) \sim x_2(t) \\ q(0) = 1 \end{cases}$$

$$4.6. \varphi : \begin{cases} y(t) = x_1(t) \sim x_2(t) \sim q(t-1) \\ q(t) = x_1(t) \vee x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.7. \varphi : \begin{cases} y(t) = x_1(t) \rightarrow (x_2(t) \rightarrow q(t-1)) \\ q(t) = x_1(t) \sim x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.8. \varphi : \begin{cases} y(t) = x_1(t) \vee x_2(t) \vee q(t-1) \\ q(t) = x_1(t)x_2(t) \\ q(0) = 1 \end{cases}$$

$$4.9. \varphi : \begin{cases} y(t) = (x_1(t) \rightarrow x_2(t)) \rightarrow q(t-1) \\ q(t) = x_1(t)x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.10. \varphi : \begin{cases} y(t) = x_1(t) \vee x_2(t) \vee q(t-1) \\ q(t) = x_1(t) \rightarrow x_2(t) \\ q(0) = 1 \end{cases}$$

$$4.11. \varphi : \begin{cases} y(t) = x_1(t)x_2(t) \rightarrow q(t-1) \\ q(t) = x_1(t) \oplus x_2(t) \\ q(0) = 1 \end{cases}$$

$$4.12. \varphi : \begin{cases} y(t) = (x_1(t) \rightarrow x_2(t)) \oplus q(t-1) \\ q(t) = x_1(t) \sim x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.13. \varphi : \begin{cases} y(t) = (x_1(t) \oplus x_2(t)) \vee q(t-1) \\ q(t) = x_1(t) \rightarrow x_2(t) \\ q(0) = 1 \end{cases}$$

$$4.14. \varphi : \begin{cases} y(t) = x_1(t)(x_2(t) \sim q(t-1)) \\ q(t) = x_1(t) \vee x_2(t) \\ q(0) = 1 \end{cases}$$

$$4.15. \varphi : \begin{cases} y(t) = x_1(t) \rightarrow \overline{x_2(t)q(t-1)} \\ q(t) = x_1(t)x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.16. \varphi : \begin{cases} y(t) = \overline{(x_1(t) \rightarrow x_2(t)) \downarrow q(t-1)} \\ q(t) = x_1(t) \rightarrow (x_2(t) \rightarrow x_1(t)) \\ q(0) = 1 \end{cases}$$

$$4.17. \varphi : \begin{cases} y(t) = x_1(t)\overline{x_2(t)} \oplus \overline{q(t-1)} \\ q(t) = x_1(t) \vee \overline{x_2(t)} \\ q(0) = 1 \end{cases}$$

$$4.18. \varphi : \begin{cases} y(t) = \overline{x_1(t) \downarrow x_2(t)} \oplus q(t-1) \\ q(t) = x_1(t) \oplus x_2(t) \oplus 1 \\ q(0) = 0 \end{cases}$$

$$4.19. \varphi : \begin{cases} y(t) = (x_1(t) \vee \overline{x_2(t)})q(t-1) \\ q(t) = (x_1(t) \oplus x_2(t)) \vee x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.20. \varphi : \begin{cases} y(t) = \overline{x_1(t)(x_2(t) \vee \overline{q(t-1)})} \\ q(t) = x_1(t) \rightarrow x_2(t) \\ q(0) = 1 \end{cases}$$

$$4.21. \varphi : \begin{cases} y(t) = (x_1(t) \oplus \overline{x_2(t)})(x_2(t) \oplus \overline{q(t-1)}) \\ q(t) = x_1(t)x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.22. \varphi : \begin{cases} y(t) = \overline{x_1(t) \downarrow (x_2(t) \mid \overline{q(t-1)})} \\ q(t) = x_1(t) \oplus x_2(t) \\ q(0) = 0 \end{cases}$$

$$4.23. \varphi : \begin{cases} y(t) = (x_1(t) \rightarrow x_2(t))(x_2(t) \rightarrow q(t-1)) \\ q(t) = x_1(t) \vee x_2(t) \\ q(0) = 1 \end{cases}$$

$$\begin{aligned}
4.24. \quad \varphi : & \begin{cases} y(t) = x_1(t) \overline{(x_2(t) \mid q(t-1))} \\ q(t) = x_1(t)x_2(t) \\ q(0) = 0 \end{cases} \\
4.25. \quad \varphi : & \begin{cases} y(t) = (x_1(t) \oplus \overline{x_2(t)}) \mid q(t-1) \\ q(t) = x_1(t) \sim x_2(t) \\ q(0) = 0 \end{cases} \\
4.26. \quad \varphi : & \begin{cases} y(t) = x_1(t) \vee x_2(t) \vee q(t-1) \\ q(t) = \overline{x_1(t)x_2(t)} \\ q(0) = 1 \end{cases} \\
4.27. \quad \varphi : & \begin{cases} y(t) = (x_1(t) \vee x_2(t)) \downarrow q(t-1) \\ q(t) = x_1(t) \oplus x_2(t) \\ q(0) = 0 \end{cases} \\
4.28. \quad \varphi : & \begin{cases} y(t) = (x_1(t)x_2(t)) \mid q(t-1) \\ q(t) = x_1(t) \sim x_2(t) \\ q(0) = 0 \end{cases} \\
4.29. \quad \varphi : & \begin{cases} y(t) = x_1(t) \oplus (x_2(t) \rightarrow q(t-1)) \\ q(t) = x_1(t)(x_1(t) \vee x_2(t)) \\ q(0) = 0 \end{cases} \\
4.30. \quad \varphi : & \begin{cases} y(t) = x_1(t) \oplus (x_2(t) \mid q(t-1)) \\ q(t) = \overline{x_1(t)} \rightarrow x_2(t) \\ q(0) = 1 \end{cases}
\end{aligned}$$

5. Для о.д.-функции  $\varphi$ , заданной системой канонических уравнений, построить диаграмму Мура.

$$5.1. \varphi : \begin{cases} y(t) = (x(t) \rightarrow q_1(t-1)) \sim q_2(t-1) \\ q_1(t) = \overline{x(t)} \oplus q_1(t-1) \\ q_2(t) = \overline{x(t)} \rightarrow q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases}$$

$$5.2. \varphi : \begin{cases} y(t) = (x(t) \sim q_1(t-1)) \vee q_2(t-1) \\ q_1(t) = x(t) \rightarrow q_1(t-1) \\ q_2(t) = x(t)(x(t) \vee q_2(t-1)) \\ q_1(0) = q_2(0) = 1 \end{cases}$$

$$5.3. \varphi : \begin{cases} y(t) = x(t)(q_1(t-1) \oplus q_2(t-1)) \\ q_1(t) = x(t) \vee q_1(t-1) \\ q_2(t) = x(t) \oplus q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases}$$

$$5.4. \varphi : \begin{cases} y(t) = x(t) \rightarrow \overline{q_1(t-1)q_2(t-1)} \\ q_1(t) = x(t)q_1(t-1) \\ q_2(t) = x(t) \sim q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases}$$

$$5.5. \varphi : \begin{cases} y(t) = \overline{(x(t) \rightarrow q_1(t-1)) \mid q_2(t-1)} \\ q_1(t) = x(t) \rightarrow (q_1(t-1) \rightarrow x(t)) \\ q_2(t) = x(t)\overline{q_2(t-1)} \\ q_1(0) = q_2(0) = 1 \end{cases}$$

$$5.6. \varphi : \begin{cases} y(t) = x(t)\overline{q_1(t-1)} \sim \overline{q_2(t-1)} \\ q_1(t) = x(t) \vee \overline{q_1(t-1)} \\ q_2(t) = x(t) \oplus q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases}$$

$$5.7. \varphi : \begin{cases} y(t) = \overline{x(t) \downarrow q_1(t-1)} \sim q_2(t-1) \\ q_1(t) = x(t) \sim q_1(t-1) \\ q_2(t) = x(t) \mid q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases}$$

$$5.8. \varphi : \begin{cases} y(t) = (x(t) \vee \overline{q_1(t-1)})q_2(t-1) \\ q_1(t) = (x(t) \sim q_1(t-1)) \vee q_1(t-1) \\ q_2(t) = x(t)q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases}$$

$$\begin{aligned}
5.9. \quad \varphi : & \begin{cases} y(t) = \overline{x(t)(q_1(t-1) \vee q_2(t-1))} \\ q_1(t) = x(t) \rightarrow q_1(t-1) \\ q_2(t) = x(t) \sim q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases} \\
5.10. \quad \varphi : & \begin{cases} y(t) = (x(t) \sim \overline{q_1(t-1)})(q_1(t-1) \sim \overline{q_2(t-1)}) \\ q_1(t) = x(t)q_1(t-1) \\ q_2(t) = x(t) \sim q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases} \\
5.11. \quad \varphi : & \begin{cases} y(t) = \overline{x(t) \downarrow (q_1(t-1) \mid \overline{q_2(t-1)})} \\ q_1(t) = x(t) \sim q_1(t-1) \\ q_2(t) = x(t)q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases} \\
5.12. \quad \varphi : & \begin{cases} y(t) = (x(t) \rightarrow q_1(t-1))(q_1(t-1) \rightarrow q_2(t-1)) \\ q_1(t) = x(t) \vee q_1(t-1) \\ q_2(t) = x(t) \sim q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases} \\
5.13. \quad \varphi : & \begin{cases} y(t) = x(t)q_1(t-1)q_2(t-1) \\ q_1(t) = x(t) \oplus q_1(t-1) \\ q_2(t) = x(t) \rightarrow q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases} \\
5.14. \quad \varphi : & \begin{cases} y(t) = x(t) \oplus q_1(t-1) \oplus q_2(t-1) \\ q_1(t) = x(t) \vee q_1(t-1) \\ q_2(t) = x(t)q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases} \\
5.15. \quad \varphi : & \begin{cases} y(t) = x(t) \rightarrow (q_1(t-1) \rightarrow q_2(t-1)) \\ q_1(t) = x(t) \oplus q_1(t-1) \\ q_2(t) = x(t) \downarrow q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases} \\
5.16. \quad \varphi : & \begin{cases} y(t) = x(t) \vee q_1(t-1) \vee q_2(t-1) \\ q_1(t) = x(t)q_1(t-1) \\ q_2(t) = x(t) \vee q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases} \\
5.17. \quad \varphi : & \begin{cases} y(t) = (x(t) \rightarrow q_1(t-1)) \rightarrow q_2(t-1) \\ q_1(t) = x(t)q_1(t-1) \\ q_2(t) = x(t) \oplus q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases}
\end{aligned}$$

$$5.18. \varphi : \begin{cases} y(t) = x(t) \vee q_1(t-1) \vee q_2(t-1) \\ q_1(t) = x(t) \rightarrow q_1(t-1) \\ q_2(t) = x(t) \vee q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases}$$

$$5.19. \varphi : \begin{cases} y(t) = x(t)q_1(t-1) \rightarrow q_2(t-1) \\ q_1(t) = x(t) \sim q_1(t-1) \\ q_2(t) = x(t) \vee q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases}$$

$$5.20. \varphi : \begin{cases} y(t) = x(t) \overline{(q_1(t-1) \mid q_2(t-1))} \\ q_1(t) = x(t) \rightarrow q_1(t-1) \\ q_2(t) = x(t)q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases}$$

$$5.21. \varphi : \begin{cases} y(t) = x(t) \oplus q_1(t-1) \oplus q_2(t-1) \\ q_1(t) = x(t) \sim q_1(t-1) \\ q_2(t) = x(t) \rightarrow q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases}$$

$$5.22. \varphi : \begin{cases} y(t) = x(t) \vee q_1(t-1) \vee q_2(t-1) \\ q_1(t) = x(t) \sim q_1(t-1) \\ q_2(t) = (x(t) \sim q_2(t-1)) \vee q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases}$$

$$5.23. \varphi : \begin{cases} y(t) = x(t) \sim q_1(t-1) \sim q_2(t-1) \\ q_1(t) = x(t)q_1(t-1) \\ q_2(t) = x(t) \sim q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases}$$

$$5.24. \varphi : \begin{cases} y(t) = (x(t) \rightarrow q_1(t-1)) \rightarrow q_2(t-1) \\ q_1(t) = x(t) \sim \overline{q_1(t-1)} \\ q_2(t) = x(t) \vee \overline{q_2(t-1)} \\ q_1(0) = q_2(0) = 0 \end{cases}$$

$$5.25. \varphi : \begin{cases} y(t) = (x(t) \sim \overline{q_1(t-1)}) \mid q_2(t-1) \\ q_1(t) = x(t) \oplus q_1(t-1) \\ q_2(t) = x(t) \rightarrow (q_2(t-1) \rightarrow x(t)) \\ q_1(0) = q_2(0) = 0 \end{cases}$$

$$5.26. \varphi : \begin{cases} y(t) = x(t) \vee \overline{q_1(t-1)} \vee q_2(t-1) \\ q_1(t) = x(t)q_1(t-1) \\ q_2(t) = x(t) \oplus q_2(t-1) \\ q_1(0) = q_2(0) = 1 \end{cases}$$

$$\begin{aligned}
5.27. \quad \varphi : & \begin{cases} y(t) = (x(t) \vee q_1(t-1)) \downarrow q_2(t-1) \\ q_1(t) = x(t) \sim q_1(t-1) \\ q_2(t) = x(t) \vee q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases} \\
5.28. \quad \varphi : & \begin{cases} y(t) = (x(t)q_1(t-1)) \mid q_2(t-1) \\ q_1(t) = x(t) \oplus q_1(t-1) \\ q_2(t) = x(t) \rightarrow q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases} \\
5.29. \quad \varphi : & \begin{cases} y(t) = x(t) \sim (q_1(t-1) \rightarrow q_2(t-1)) \\ q_1(t) = x(t)(x(t) \vee q_1(t-1)) \\ q_2(t) = x(t) \oplus q_2(t-1) \\ q_1(0) = q_2(0) = 0 \end{cases} \\
5.30. \quad \varphi : & \begin{cases} y(t) = x(t) \sim (q_1(t-1) \mid q_2(t-1)) \\ q_1(t) = \overline{x(t)} \rightarrow q_1(t-1) \\ q_2(t) = q_2(t-1) \rightarrow x(t) \\ q_1(0) = q_2(0) = 1 \end{cases}
\end{aligned}$$



6. Проверить однозначную декодируемость кода  $C$ .

- 6.1.  $C = \{1001, 012, 0120, 112, 12, 10, 02\}$
- 6.2.  $C = \{1000, 022, 221, 12, 2012, 00, 20\}$
- 6.3.  $C = \{12, 2100, 0212, 2010, 01, 11, 010\}$
- 6.4.  $C = \{011, 01, 22, 122, 21, 0220, 1011\}$
- 6.5.  $C = \{200, 12, 202, 112, 210, 11, 20, 212\}$
- 6.6.  $C = \{02, 10, 121, 1022, 102, 11, 001, 0211\}$
- 6.7.  $C = \{02, 0222, 22, 12, 0100, 11, 221, 0022\}$
- 6.8.  $C = \{0210, 22, 010, 20, 01, 001, 0021\}$
- 6.9.  $C = \{2221, 000, 00, 01, 22, 10, 0012, 011\}$
- 6.10.  $C = \{00, 22, 221, 02, 220, 121, 222, 100\}$
- 6.11.  $C = \{21, 10, 002, 2110, 1020, 0012, 200\}$
- 6.12.  $C = \{20, 01, 1000, 0002, 12, 22, 11, 1112\}$
- 6.13.  $C = \{01, 122, 10, 0122, 121, 22, 200, 012\}$
- 6.14.  $C = \{112, 0210, 02, 21, 11, 221, 212, 1211\}$
- 6.15.  $C = \{1000, 222, 001, 02, 2021, 22, 210\}$
- 6.16.  $C = \{0220, 20, 1021, 12, 02, 00, 111, 1110\}$
- 6.17.  $C = \{10, 00, 11, 0021, 2002, 002, 121\}$
- 6.18.  $C = \{1122, 11, 1100, 122, 001, 2211\}$
- 6.19.  $C = \{21, 10, 22, 0111, 11, 2201, 020, 2011\}$
- 6.20.  $C = \{21, 2210, 02, 122, 0221, 012, 211\}$
- 6.21.  $C = \{200, 22, 1122, 10, 2110, 1022, 0222\}$
- 6.22.  $C = \{112, 210, 100, 11, 10, 001, 20, 1111\}$
- 6.23.  $C = \{112, 022, 12, 221, 2220, 0012, 00\}$
- 6.24.  $C = \{201, 0001, 01, 12, 10, 21, 220, 22\}$
- 6.25.  $C = \{022, 22, 0000, 00, 0220, 210, 112\}$
- 6.26.  $C = \{11, 20, 2110, 10, 00, 011, 202, 1222\}$
- 6.27.  $C = \{2210, 21, 222, 0222, 0220, 221\}$
- 6.28.  $C = \{011, 0000, 00, 0122, 21, 22, 022\}$
- 6.29.  $C = \{00, 11, 0022, 21, 20, 002, 02, 001\}$
- 6.30.  $C = \{1201, 20, 201, 0201, 120, 01, 200\}$

7. Проверить, является ли  $B$  кодом ровно одного сообщения в кодировании  $C$ .

- 7.1.  $C = \{1201, 0110, 110, 00, 212, 10, 21\}$ ,  $B = 12012121102100212212$
- 7.2.  $C = \{022, 22, 120, 2011, 21, 00, 0000\}$ ,  $B = 2220110000201122022022$
- 7.3.  $C = \{1000, 21, 22, 222, 12, 0101, 0202\}$ ,  $B = 12212222020202022220202$
- 7.4.  $C = \{11, 2102, 01, 1221, 0122, 22, 020\}$ ,  $B = 2201222102012201221221$
- 7.5.  $C = \{101, 21, 20, 102, 221, 00, 01, 010\}$ ,  $B = 000101010100011022001$
- 7.6.  $C = \{01, 20, 1120, 12, 012, 02, 21, 100\}$ ,  $B = 100211120100011120012$
- 7.7.  $C = \{0202, 02, 210, 21, 2200, 00, 001\}$ ,  $B = 00121022000202001022200$
- 7.8.  $C = \{10, 1212, 2022, 21, 100, 212, 201\}$ ,  $B = 20121221121221100212$
- 7.9.  $C = \{20, 22, 0200, 1112, 0222, 2002\}$ ,  $B = 2002200211120200202002$
- 7.10.  $C = \{120, 20, 221, 122, 22, 2201, 02, 10\}$ ,  $B = 1222220202022221122122$
- 7.11.  $C = \{1210, 00, 200, 21, 111, 121, 021\}$ ,  $B = 0212112121200111121200$
- 7.12.  $C = \{20, 02, 2120, 010, 120, 0221, 102\}$ ,  $B = 2021202120022102010102$
- 7.13.  $C = \{02, 1102, 21, 0100, 020, 002, 0220\}$ ,  $B = 0220211102110211021102$
- 7.14.  $C = \{20, 21, 2020, 12, 01, 11, 210, 201\}$ ,  $B = 2020202020212100112201$
- 7.15.  $C = \{102, 112, 12, 2210, 00, 11, 121, 2120\}$ ,  $B = 12111212111222102210$
- 7.16.  $C = \{22, 022, 212, 20, 1011, 02, 211, 2200\}$ ,  $B = 201011101121222211212$
- 7.17.  $C = \{12, 0110, 110, 20, 00, 10, 02, 22, 200\}$ ,  $B = 11012110002002200110$
- 7.18.  $C = \{2011, 201, 220, 01, 12, 0201, 0021\}$ ,  $B = 220002120112012202011$
- 7.19.  $C = \{1120, 22, 0100, 021, 100, 220, 2202\}$ ,  $B = 22112022011200100021$
- 7.20.  $C = \{211, 22, 011, 1212, 21, 1100, 121\}$ ,  $B = 22121211211211210111100$
- 7.21.  $C = \{21, 22, 122, 02, 0011, 2111, 1220\}$ ,  $B = 00111220220011220011$
- 7.22.  $C = \{01, 001, 1022, 120, 12, 010, 211\}$ ,  $B = 120102212121200101010$
- 7.23.  $C = \{20, 121, 22, 0011, 01, 1100, 10, 001\}$ ,  $B = 00120110012120012201$
- 7.24.  $C = \{00, 000, 12, 20, 22, 0202, 2110, 01\}$ ,  $B = 20000000002110002000$
- 7.25.  $C = \{00, 12, 22, 0021, 01, 100, 11, 222\}$ ,  $B = 01100110021122222100$
- 7.26.  $C = \{2101, 002, 12, 120, 21, 1002, 122\}$ ,  $B = 122122120002122121002$
- 7.27.  $C = \{2021, 00, 000, 0112, 11, 200, 21\}$ ,  $B = 21202100000112202100$
- 7.28.  $C = \{12, 011, 210, 202, 21, 2112, 112\}$ ,  $B = 120111120112121001112$
- 7.29.  $C = \{0012, 20, 210, 220, 2121, 2102\}$ ,  $B = 21022102202102210202121$
- 7.30.  $C = \{21, 0011, 20, 2122, 220, 0220, 211\}$ ,  $B = 212221022021102200220$

8. Построить двоичный префиксный код с заданной последовательностью длин кодовых слов  $L$ .

- 8.1.  $L = (3, 3, 3, 3)$
- 8.2.  $L = (1, 2, 5, 6)$
- 8.3.  $L = (3, 4, 4, 4)$
- 8.4.  $L = (2, 2, 2, 3)$
- 8.5.  $L = (1, 3, 3, 5)$
- 8.6.  $L = (2, 3, 3, 4)$
- 8.7.  $L = (3, 4, 4, 5)$
- 8.8.  $L = (1, 2, 5, 5)$
- 8.9.  $L = (3, 3, 4, 5)$
- 8.10.  $L = (3, 4, 6, 6)$
- 8.11.  $L = (3, 5, 5, 5)$
- 8.12.  $L = (3, 3, 3, 4)$
- 8.13.  $L = (1, 3, 4, 5)$
- 8.14.  $L = (1, 2, 3, 6)$
- 8.15.  $L = (3, 4, 5, 6)$
- 8.16.  $L = (1, 4, 5, 6)$
- 8.17.  $L = (2, 2, 3, 3)$
- 8.18.  $L = (1, 2, 4, 4)$
- 8.19.  $L = (2, 3, 4, 5)$
- 8.20.  $L = (2, 2, 3, 4)$
- 8.21.  $L = (1, 3, 3, 3)$
- 8.22.  $L = (2, 2, 2, 5)$
- 8.23.  $L = (1, 2, 3, 5)$
- 8.24.  $L = (3, 4, 5, 5)$
- 8.25.  $L = (1, 3, 3, 4)$
- 8.26.  $L = (2, 3, 3, 3)$
- 8.27.  $L = (1, 4, 4, 4)$
- 8.28.  $L = (2, 2, 2, 4)$
- 8.29.  $L = (2, 3, 4, 4)$
- 8.30.  $L = (1, 2, 3, 4)$

9. Построить двоичный префиксный код с заданной последовательностью длин кодовых слов  $L$ .

- 9.1.  $L = (2, 2, 2, 5, 6, 7)$
- 9.2.  $L = (3, 3, 3, 4, 4, 4)$
- 9.3.  $L = (3, 4, 4, 5, 5, 5)$
- 9.4.  $L = (2, 2, 3, 4, 5, 6)$
- 9.5.  $L = (3, 4, 5, 6, 6, 7)$
- 9.6.  $L = (2, 2, 3, 3, 3, 4)$
- 9.7.  $L = (1, 2, 5, 6, 7, 7)$
- 9.8.  $L = (2, 3, 4, 4, 5, 5)$
- 9.9.  $L = (3, 4, 5, 5, 6, 6)$
- 9.10.  $L = (2, 3, 4, 5, 6, 6)$
- 9.11.  $L = (2, 3, 3, 4, 4, 4)$
- 9.12.  $L = (1, 2, 3, 4, 5, 6)$
- 9.13.  $L = (1, 2, 4, 4, 5, 6)$
- 9.14.  $L = (3, 3, 4, 5, 5, 5)$
- 9.15.  $L = (3, 4, 4, 4, 5, 5)$
- 9.16.  $L = (2, 3, 4, 5, 6, 7)$
- 9.17.  $L = (3, 4, 4, 4, 4, 5)$
- 9.18.  $L = (1, 3, 4, 4, 5, 6)$
- 9.19.  $L = (2, 3, 4, 4, 4, 4)$
- 9.20.  $L = (2, 2, 3, 3, 4, 4)$
- 9.21.  $L = (3, 3, 3, 4, 5, 5)$
- 9.22.  $L = (3, 3, 4, 4, 4, 4)$
- 9.23.  $L = (1, 3, 3, 4, 5, 6)$
- 9.24.  $L = (3, 3, 4, 4, 5, 5)$
- 9.25.  $L = (2, 3, 3, 4, 4, 5)$
- 9.26.  $L = (3, 3, 3, 3, 3, 4)$
- 9.27.  $L = (3, 4, 5, 6, 7, 7)$
- 9.28.  $L = (2, 3, 4, 4, 4, 5)$
- 9.29.  $L = (1, 2, 3, 5, 5, 6)$
- 9.30.  $L = (2, 2, 2, 5, 6, 6)$

10. Построить  $q$ -ичный префиксный код ( $q = 3$ ) с заданной последовательностью длин кодовых слов  $L$ .

- 10.1.  $L = (2, 3, 3, 3)$
- 10.2.  $L = (2, 2, 2, 3)$
- 10.3.  $L = (3, 3, 3, 5)$
- 10.4.  $L = (2, 2, 3, 3)$
- 10.5.  $L = (1, 3, 3, 4)$
- 10.6.  $L = (3, 4, 4, 5)$
- 10.7.  $L = (1, 1, 2, 4)$
- 10.8.  $L = (3, 3, 3, 3)$
- 10.9.  $L = (1, 1, 4, 4)$
- 10.10.  $L = (1, 2, 2, 3)$
- 10.11.  $L = (1, 1, 2, 5)$
- 10.12.  $L = (3, 4, 4, 4)$
- 10.13.  $L = (1, 1, 2, 2)$
- 10.14.  $L = (3, 3, 4, 5)$
- 10.15.  $L = (1, 1, 3, 3)$
- 10.16.  $L = (3, 4, 5, 6)$
- 10.17.  $L = (2, 2, 3, 4)$
- 10.18.  $L = (3, 3, 4, 4)$
- 10.19.  $L = (3, 3, 3, 4)$
- 10.20.  $L = (1, 2, 3, 4)$
- 10.21.  $L = (1, 2, 2, 2)$
- 10.22.  $L = (2, 3, 4, 4)$
- 10.23.  $L = (1, 1, 3, 4)$
- 10.24.  $L = (1, 2, 3, 3)$
- 10.25.  $L = (2, 2, 2, 4)$
- 10.26.  $L = (2, 3, 3, 4)$
- 10.27.  $L = (2, 2, 2, 5)$
- 10.28.  $L = (2, 2, 2, 2)$
- 10.29.  $L = (1, 1, 2, 3)$
- 10.30.  $L = (3, 4, 5, 5)$

11. Построить  $q$ -ичный префиксный код ( $q = 3$ ) с заданной последовательностью длин кодовых слов  $L$ .

- 11.1.  $L = (3, 3, 3, 3, 3)$
- 11.2.  $L = (3, 3, 3, 3, 3, 5)$
- 11.3.  $L = (3, 4, 5, 6, 7, 8)$
- 11.4.  $L = (1, 2, 3, 3, 4, 4)$
- 11.5.  $L = (3, 3, 4, 4, 5, 5)$
- 11.6.  $L = (2, 3, 3, 4, 4, 4)$
- 11.7.  $L = (3, 4, 5, 5, 5, 6)$
- 11.8.  $L = (2, 3, 4, 4, 5, 6)$
- 11.9.  $L = (1, 2, 2, 3, 4, 4)$
- 11.10.  $L = (2, 2, 2, 2, 2, 2)$
- 11.11.  $L = (2, 2, 3, 3, 3, 4)$
- 11.12.  $L = (1, 2, 2, 2, 3, 3)$
- 11.13.  $L = (2, 2, 2, 2, 2, 3)$
- 11.14.  $L = (2, 2, 3, 3, 3, 3)$
- 11.15.  $L = (1, 1, 2, 2, 3, 4)$
- 11.16.  $L = (3, 3, 3, 3, 4, 5)$
- 11.17.  $L = (1, 2, 2, 2, 3, 4)$
- 11.18.  $L = (3, 4, 4, 4, 4, 4)$
- 11.19.  $L = (1, 2, 2, 3, 3, 4)$
- 11.20.  $L = (3, 4, 5, 6, 6, 7)$
- 11.21.  $L = (2, 3, 3, 3, 3, 3)$
- 11.22.  $L = (2, 3, 4, 5, 5, 5)$
- 11.23.  $L = (1, 2, 2, 2, 2, 2)$
- 11.24.  $L = (3, 3, 4, 5, 5, 6)$
- 11.25.  $L = (1, 2, 3, 4, 5, 5)$
- 11.26.  $L = (2, 2, 2, 3, 3, 3)$
- 11.27.  $L = (2, 3, 4, 4, 4, 4)$
- 11.28.  $L = (1, 2, 3, 4, 4, 4)$
- 11.29.  $L = (3, 3, 3, 4, 4, 4)$
- 11.30.  $L = (3, 4, 4, 4, 5, 5)$

12. Построить оптимальный двоичный код для заданного распределения вероятностей  $P$ .

- 12.1.  $P = (0, 37; 0, 13; 0, 14; 0, 19; 0, 11; 0, 06)$
- 12.2.  $P = (0, 06; 0, 32; 0, 17; 0, 18; 0, 03; 0, 24)$
- 12.3.  $P = (0, 62; 0, 23; 0, 09; 0, 01; 0, 03; 0, 02)$
- 12.4.  $P = (0, 58; 0, 17; 0, 14; 0, 07; 0, 02; 0, 02)$
- 12.5.  $P = (0, 55; 0, 01; 0, 12; 0, 04; 0, 12; 0, 16)$
- 12.6.  $P = (0, 44; 0, 08; 0, 24; 0, 09; 0, 01; 0, 14)$
- 12.7.  $P = (0, 55; 0, 18; 0, 07; 0, 11; 0, 04; 0, 05)$
- 12.8.  $P = (0, 51; 0, 03; 0, 14; 0, 07; 0, 13; 0, 12)$
- 12.9.  $P = (0, 54; 0, 07; 0, 13; 0, 05; 0, 06; 0, 15)$
- 12.10.  $P = (0, 44; 0, 26; 0, 01; 0, 18; 0, 01; 0, 1)$
- 12.11.  $P = (0, 62; 0, 08; 0, 02; 0, 01; 0, 03; 0, 24)$
- 12.12.  $P = (0, 04; 0, 3; 0, 17; 0, 3; 0, 03; 0, 16)$
- 12.13.  $P = (0, 45; 0, 01; 0, 26; 0, 17; 0, 03; 0, 08)$
- 12.14.  $P = (0, 06; 0, 44; 0, 31; 0, 03; 0, 04; 0, 12)$
- 12.15.  $P = (0, 28; 0, 32; 0, 13; 0, 18; 0, 06; 0, 03)$
- 12.16.  $P = (0, 51; 0, 16; 0, 1; 0, 13; 0, 06; 0, 04)$
- 12.17.  $P = (0, 6; 0, 09; 0, 12; 0, 02; 0, 08; 0, 09)$
- 12.18.  $P = (0, 66; 0, 05; 0, 06; 0, 01; 0, 1; 0, 12)$
- 12.19.  $P = (0, 05; 0, 63; 0, 05; 0, 13; 0, 06; 0, 08)$
- 12.20.  $P = (0, 41; 0, 28; 0, 03; 0, 17; 0, 07; 0, 04)$
- 12.21.  $P = (0, 27; 0, 04; 0, 05; 0, 17; 0, 12; 0, 35)$
- 12.22.  $P = (0, 25; 0, 16; 0, 2; 0, 03; 0, 03; 0, 33)$
- 12.23.  $P = (0, 18; 0, 47; 0, 02; 0, 21; 0, 01; 0, 11)$
- 12.24.  $P = (0, 3; 0, 09; 0, 23; 0, 19; 0, 05; 0, 14)$
- 12.25.  $P = (0, 54; 0, 2; 0, 09; 0, 07; 0, 06; 0, 04)$
- 12.26.  $P = (0, 1; 0, 12; 0, 1; 0, 24; 0, 04; 0, 4)$
- 12.27.  $P = (0, 45; 0, 33; 0, 01; 0, 13; 0, 01; 0, 07)$
- 12.28.  $P = (0, 61; 0, 22; 0, 05; 0, 08; 0, 01; 0, 03)$
- 12.29.  $P = (0, 16; 0, 05; 0, 46; 0, 07; 0, 14; 0, 12)$
- 12.30.  $P = (0, 34; 0, 37; 0, 04; 0, 09; 0, 1; 0, 06)$

13. Построить оптимальный  $q$ -ичный код ( $q=3$ ) для заданного распределения вероятностей  $P$ .

- 13.1.  $P = (0,09; 0,04; 0,23; 0,2; 0,28; 0,16)$
- 13.2.  $P = (0,57; 0,26; 0,07; 0,01; 0,05; 0,04)$
- 13.3.  $P = (0,62; 0,03; 0,22; 0,05; 0,02; 0,06)$
- 13.4.  $P = (0,27; 0,38; 0,09; 0,07; 0,09; 0,1)$
- 13.5.  $P = (0,58; 0,06; 0,1; 0,08; 0,11; 0,07)$
- 13.6.  $P = (0,08; 0,17; 0,18; 0,17; 0,2; 0,2)$
- 13.7.  $P = (0,31; 0,05; 0,13; 0,09; 0,24; 0,18)$
- 13.8.  $P = (0,01; 0,62; 0,06; 0,18; 0,02; 0,11)$
- 13.9.  $P = (0,47; 0,35; 0,04; 0,04; 0,02; 0,08)$
- 13.10.  $P = (0,56; 0,29; 0,01; 0,06; 0,01; 0,07)$
- 13.11.  $P = (0,55; 0,05; 0,05; 0,22; 0,09; 0,04)$
- 13.12.  $P = (0,37; 0,32; 0,2; 0,01; 0,03; 0,07)$
- 13.13.  $P = (0,65; 0,15; 0,01; 0,01; 0,07; 0,11)$
- 13.14.  $P = (0,1; 0,14; 0,18; 0,22; 0,23; 0,13)$
- 13.15.  $P = (0,15; 0,25; 0,27; 0,17; 0,06; 0,1)$
- 13.16.  $P = (0,61; 0,11; 0,1; 0,06; 0,04; 0,08)$
- 13.17.  $P = (0,36; 0,29; 0,22; 0,04; 0,04; 0,05)$
- 13.18.  $P = (0,15; 0,55; 0,06; 0,13; 0,07; 0,04)$
- 13.19.  $P = (0,66; 0,09; 0,07; 0,01; 0,09; 0,08)$
- 13.20.  $P = (0,5; 0,19; 0,02; 0,04; 0,05; 0,2)$
- 13.21.  $P = (0,2; 0,47; 0,13; 0,09; 0,04; 0,07)$
- 13.22.  $P = (0,41; 0,3; 0,16; 0,07; 0,01; 0,05)$
- 13.23.  $P = (0,33; 0,24; 0,04; 0,09; 0,14; 0,16)$
- 13.24.  $P = (0,53; 0,11; 0,13; 0,01; 0,15; 0,07)$
- 13.25.  $P = (0,07; 0,47; 0,22; 0,12; 0,05; 0,07)$
- 13.26.  $P = (0,12; 0,43; 0,28; 0,08; 0,05; 0,04)$
- 13.27.  $P = (0,61; 0,1; 0,15; 0,05; 0,05; 0,04)$
- 13.28.  $P = (0,5; 0,13; 0,11; 0,04; 0,02; 0,2)$
- 13.29.  $P = (0,63; 0,17; 0,05; 0,04; 0,04; 0,07)$
- 13.30.  $P = (0,23; 0,4; 0,05; 0,16; 0,08; 0,08)$



14. Построить по методу Хэмминга кодовое слово для сообщения  $\alpha$ .

- 14.1.  $\alpha = 10000$
- 14.2.  $\alpha = 01000$
- 14.3.  $\alpha = 11000$
- 14.4.  $\alpha = 00100$
- 14.5.  $\alpha = 10100$
- 14.6.  $\alpha = 01100$
- 14.7.  $\alpha = 11100$
- 14.8.  $\alpha = 00010$
- 14.9.  $\alpha = 10010$
- 14.10.  $\alpha = 01010$
- 14.11.  $\alpha = 11010$
- 14.12.  $\alpha = 00110$
- 14.13.  $\alpha = 10110$
- 14.14.  $\alpha = 01110$
- 14.15.  $\alpha = 11110$
- 14.16.  $\alpha = 00001$
- 14.17.  $\alpha = 10001$
- 14.18.  $\alpha = 01001$
- 14.19.  $\alpha = 11001$
- 14.20.  $\alpha = 00101$
- 14.21.  $\alpha = 10101$
- 14.22.  $\alpha = 01101$
- 14.23.  $\alpha = 11101$
- 14.24.  $\alpha = 00011$
- 14.25.  $\alpha = 10011$
- 14.26.  $\alpha = 01011$
- 14.27.  $\alpha = 11011$
- 14.28.  $\alpha = 00111$
- 14.29.  $\alpha = 10111$
- 14.30.  $\alpha = 01111$

15. По кодовому слову  $\beta$ , построенному по методу Хэмминга, восстановить исходное сообщение, если известно, что произошло не более одной ошибки.

- 15.1.  $\beta = 100000000$
- 15.2.  $\beta = 001000000$
- 15.3.  $\beta = 111000000$
- 15.4.  $\beta = 010100000$
- 15.5.  $\beta = 101100000$
- 15.6.  $\beta = 000010000$
- 15.7.  $\beta = 110010000$
- 15.8.  $\beta = 011010000$
- 15.9.  $\beta = 100110000$
- 15.10.  $\beta = 001110000$
- 15.11.  $\beta = 111110000$
- 15.12.  $\beta = 010001000$
- 15.13.  $\beta = 101001000$
- 15.14.  $\beta = 000101000$
- 15.15.  $\beta = 110101000$
- 15.16.  $\beta = 011101000$
- 15.17.  $\beta = 100011000$
- 15.18.  $\beta = 001011000$
- 15.19.  $\beta = 111011000$
- 15.20.  $\beta = 010111000$
- 15.21.  $\beta = 101111000$
- 15.22.  $\beta = 000000100$
- 15.23.  $\beta = 110000100$
- 15.24.  $\beta = 011000100$
- 15.25.  $\beta = 100100100$
- 15.26.  $\beta = 001100100$
- 15.27.  $\beta = 111100100$
- 15.28.  $\beta = 010010100$
- 15.29.  $\beta = 101010100$
- 15.30.  $\beta = 000110100$

16. Для кода  $C$  определить, сколько ошибок он обнаруживает и сколько исправляет.

- 16.1.  $C = \{11010010, 01010100, 01101100, 10100000\}$
- 16.2.  $C = \{10110000, 11011010, 01000010, 00110110\}$
- 16.3.  $C = \{11011000, 00001101, 00001000, 11000111\}$
- 16.4.  $C = \{00000101, 10110000, 01100111, 01001110\}$
- 16.5.  $C = \{01101110, 10000100, 01010110, 11100011\}$
- 16.6.  $C = \{10111011, 11110110, 00110000, 00000010\}$
- 16.7.  $C = \{10000111, 01111010, 11100100, 00000101\}$
- 16.8.  $C = \{10101000, 01111100, 11011111, 10000000\}$
- 16.9.  $C = \{10111110, 01000010, 10100010, 00101000\}$
- 16.10.  $C = \{01100110, 01001010, 11001001, 00010011\}$
- 16.11.  $C = \{01100011, 00000101, 00011001, 01010011\}$
- 16.12.  $C = \{00010000, 00101101, 01010110, 11100100\}$
- 16.13.  $C = \{01111001, 01011111, 01101111, 11101011\}$
- 16.14.  $C = \{11111110, 01110110, 10100110, 00111001\}$
- 16.15.  $C = \{00011101, 10110100, 00101001, 11000100\}$
- 16.16.  $C = \{10010101, 01010100, 00100001, 10100101\}$
- 16.17.  $C = \{11101001, 10110110, 11000001, 11100010\}$
- 16.18.  $C = \{00100111, 10100011, 11010101, 11001010\}$
- 16.19.  $C = \{11110001, 11010011, 00010011, 01101110\}$
- 16.20.  $C = \{10000101, 01000101, 10000000, 00110110\}$
- 16.21.  $C = \{11101011, 11001110, 00001100, 01001011\}$
- 16.22.  $C = \{00000111, 01101101, 01011110, 00010011\}$
- 16.23.  $C = \{11010011, 10110101, 11111010, 10101100\}$
- 16.24.  $C = \{10111100, 10000000, 10011101, 11100101\}$
- 16.25.  $C = \{00100000, 01010001, 11001101, 10010101\}$
- 16.26.  $C = \{00101100, 01100111, 01001101, 10101000\}$
- 16.27.  $C = \{11000100, 00000100, 01001011, 01110110\}$
- 16.28.  $C = \{00011110, 00100000, 01000110, 01111111\}$
- 16.29.  $C = \{11111110, 01000011, 11110010, 10010110\}$
- 16.30.  $C = \{01110001, 10111111, 01100010, 10110000\}$

17. Определить, сколько ошибок обнаруживает и сколько исправляет код с характеристической функцией  $f$ .

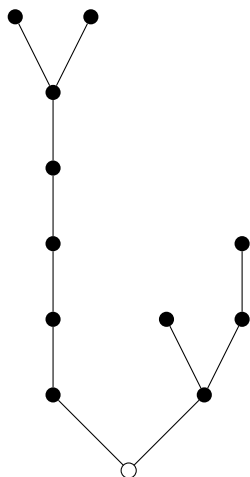
- 17.1.  $x_2(x_3 \oplus x_1)(x_3 \oplus x_4)$
- 17.2.  $x_4(x_2 \sim x_1)(x_3 \sim x_2)$
- 17.3.  $x_4 \downarrow ((x_1 \sim x_3) \mid (x_2 \sim x_1))$
- 17.4.  $x_3 \downarrow ((x_1 \sim x_2) \vee (x_1 \sim x_4))$
- 17.5.  $\overline{(x_1 \oplus x_3)}(x_4 \downarrow (x_2 \sim x_1))$
- 17.6.  $x_3((x_4 \oplus x_1) \downarrow (x_2 \oplus x_1))$
- 17.7.  $((x_1 \oplus x_2) \downarrow (x_1 \sim x_3))x_4$
- 17.8.  $((x_3 \sim x_1) \vee (x_1 \sim x_4)) \downarrow x_2$
- 17.9.  $(x_4 \sim x_3)(\bar{x}_1 \downarrow (x_2 \oplus x_4))$
- 17.10.  $(x_1 \vee (x_4 \oplus x_3)) \downarrow (x_4 \sim x_2)$
- 17.11.  $((x_2 \oplus x_3) \vee (x_1 \sim x_3)) \downarrow x_4$
- 17.12.  $(x_4 \mid (x_3 \sim x_2)) \downarrow (x_2 \oplus x_1)$
- 17.13.  $((x_4 \oplus x_1) \rightarrow x_3) \downarrow (\bar{x}_1 \sim \bar{x}_2)$
- 17.14.  $(x_2 \mid (x_3 \oplus x_1)) \downarrow (x_4 \oplus x_1)$
- 17.15.  $(x_1 \rightarrow (x_3 \oplus x_4)) \downarrow (x_4 \sim x_2)$
- 17.16.  $x_4 \downarrow ((x_1 \sim x_3) \mid (x_2 \oplus x_3))$
- 17.17.  $(x_3 \oplus x_4) \downarrow (x_2 \vee (x_1 \oplus x_3))$
- 17.18.  $x_1 \downarrow ((x_3 \oplus x_4) \mid (x_4 \oplus x_2))$
- 17.19.  $x_3 \downarrow ((x_4 \sim x_1) \rightarrow (x_4 \sim x_2))$
- 17.20.  $(x_1 \oplus x_2) \downarrow (x_3 \vee (x_2 \oplus x_4))$
- 17.21.  $(x_2 \downarrow (x_1 \oplus x_4))(x_1 \oplus x_3)$
- 17.22.  $x_2 \downarrow ((x_4 \sim x_1) \mid (x_3 \oplus x_1))$
- 17.23.  $(x_2 \rightarrow (x_4 \oplus x_1)) \downarrow (x_3 \oplus x_1)$
- 17.24.  $(x_3 \sim x_1) \downarrow ((x_1 \sim x_4) \rightarrow x_2)$
- 17.25.  $(x_1 \vee (x_4 \sim x_3)) \downarrow (x_3 \oplus x_2)$
- 17.26.  $((x_1 \sim x_4) \mid (x_4 \oplus x_3)) \downarrow x_2$
- 17.27.  $x_4((x_3 \oplus x_2) \downarrow (x_2 \sim x_1))$
- 17.28.  $x_1(x_3 \oplus x_2)(x_2 \sim x_1 \sim x_4)$
- 17.29.  $(x_2 \oplus x_3) \downarrow ((x_1 \oplus x_2) \vee x_4)$
- 17.30.  $((x_4 \oplus x_1) \mid x_3) \downarrow (x_1 \sim x_2)$

18. Построить плоское корневое дерево по его коду  $\tilde{\alpha}$ .

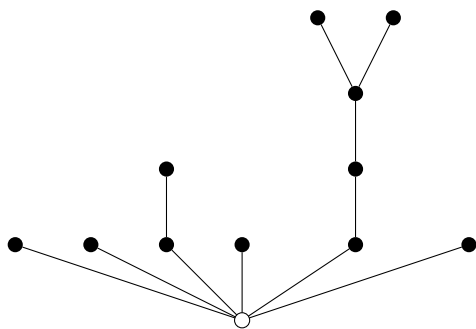
- 18.1.  $\tilde{\alpha} = 0000010111110100101101$
- 18.2.  $\tilde{\alpha} = 0100110101000011110011$
- 18.3.  $\tilde{\alpha} = 0100000011000110111111$
- 18.4.  $\tilde{\alpha} = 0001100001010001111111$
- 18.5.  $\tilde{\alpha} = 0100000111110100001111$
- 18.6.  $\tilde{\alpha} = 0011010101001100001111$
- 18.7.  $\tilde{\alpha} = 0001011100011101001101$
- 18.8.  $\tilde{\alpha} = 0101010000100011011111$
- 18.9.  $\tilde{\alpha} = 0101000100101000111111$
- 18.10.  $\tilde{\alpha} = 0000000110100111101111$
- 18.11.  $\tilde{\alpha} = 0001011100100100111101$
- 18.12.  $\tilde{\alpha} = 0000110110110101010101$
- 18.13.  $\tilde{\alpha} = 0010001010110101010111$
- 18.14.  $\tilde{\alpha} = 0100000100000111111111$
- 18.15.  $\tilde{\alpha} = 0101000011011100001111$
- 18.16.  $\tilde{\alpha} = 0101001010110101001011$
- 18.17.  $\tilde{\alpha} = 0101010101000110001111$
- 18.18.  $\tilde{\alpha} = 0000010100111011110101$
- 18.19.  $\tilde{\alpha} = 0101000101001111010011$
- 18.20.  $\tilde{\alpha} = 0001110011001001100111$
- 18.21.  $\tilde{\alpha} = 0100001010011011101011$
- 18.22.  $\tilde{\alpha} = 0100110010101010110011$
- 18.23.  $\tilde{\alpha} = 0101000111010100001111$
- 18.24.  $\tilde{\alpha} = 0011010100110011010011$
- 18.25.  $\tilde{\alpha} = 0000000111111011010011$
- 18.26.  $\tilde{\alpha} = 0010110101010001011101$
- 18.27.  $\tilde{\alpha} = 0101010000101101001111$
- 18.28.  $\tilde{\alpha} = 0101001011001100001111$
- 18.29.  $\tilde{\alpha} = 0011010101010101010011$
- 18.30.  $\tilde{\alpha} = 0010001110110100110011$

19. Построить код плоского корневого дерева.

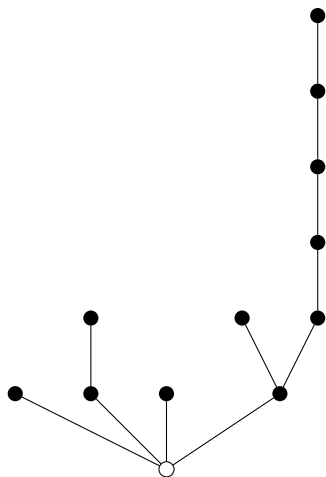
19.1.



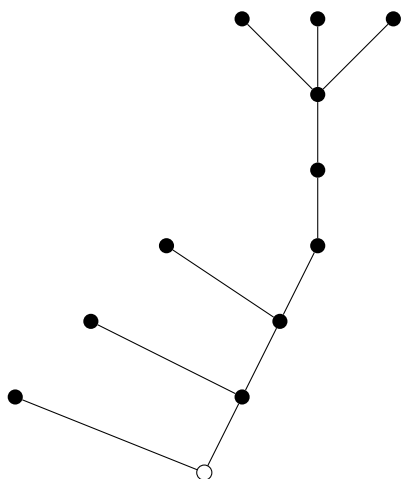
19.2.



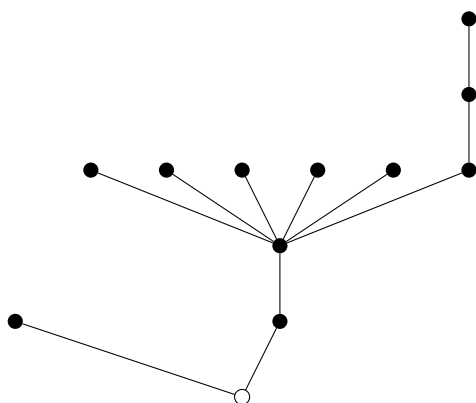
19.3.



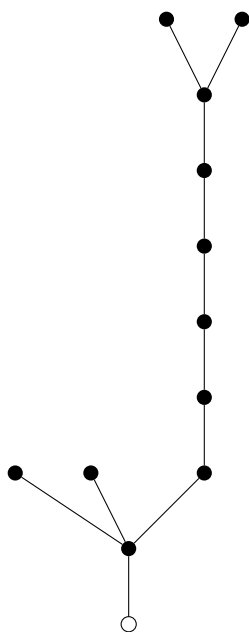
19.4.



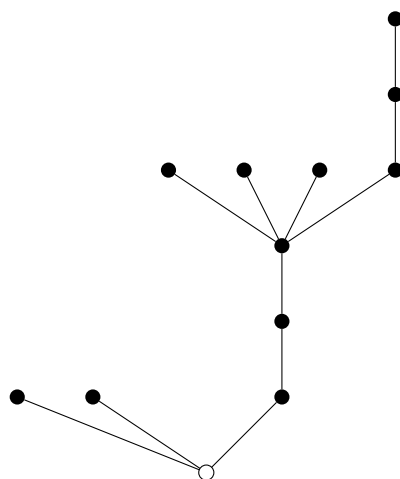
19.5.



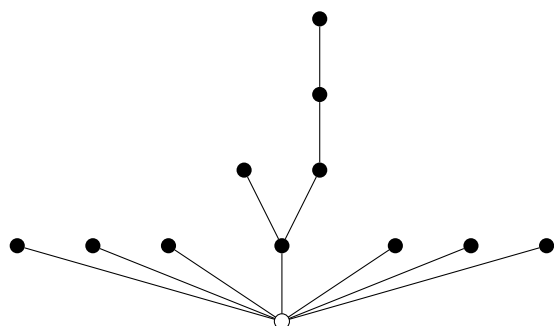
19.6.



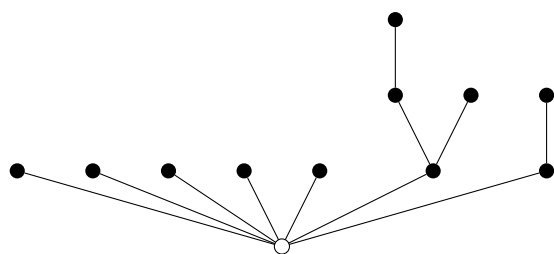
19.7.



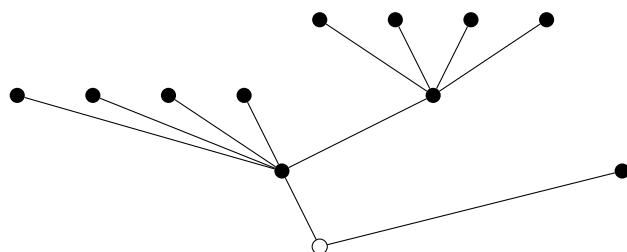
19.8.



19.9.

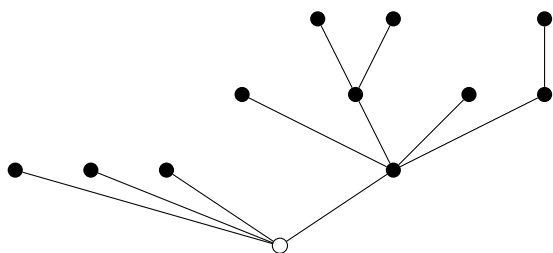


19.10.

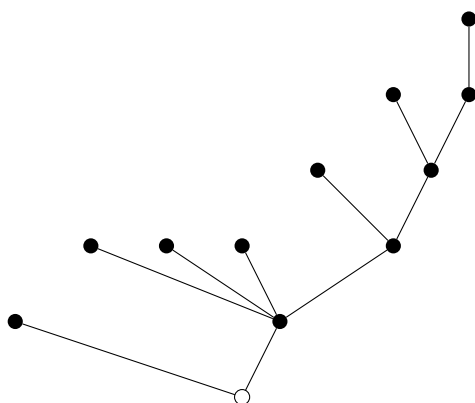




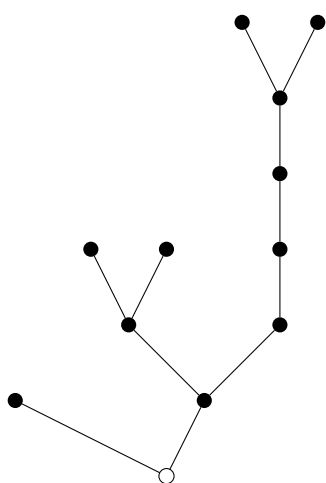
19.11.



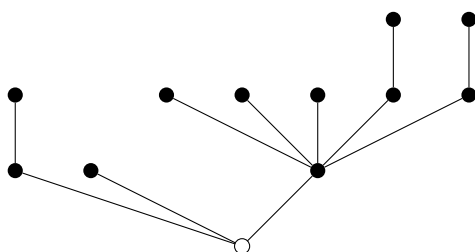
19.12.



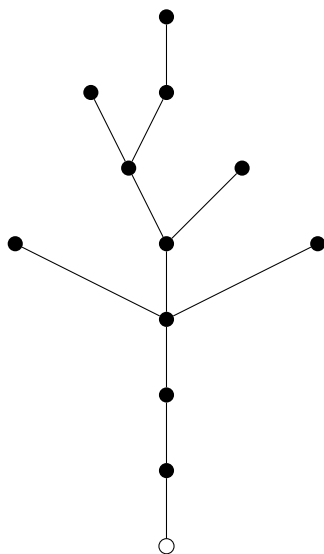
19.13.



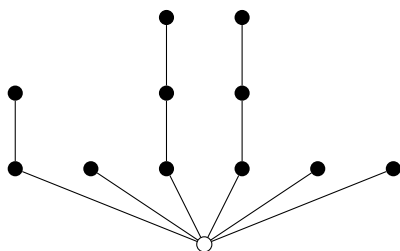
19.14.



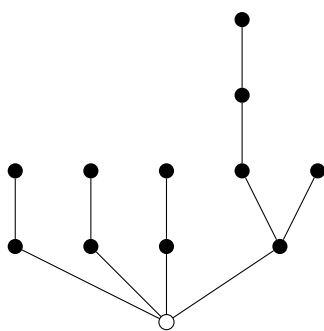
19.15.



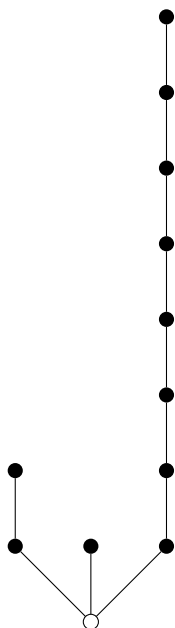
19.16.



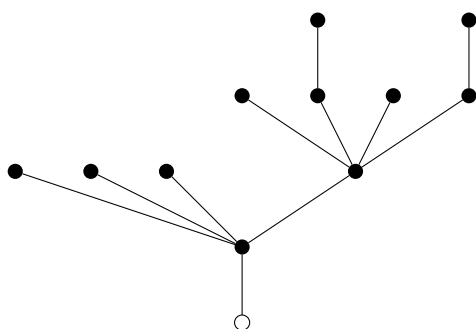
19.17.



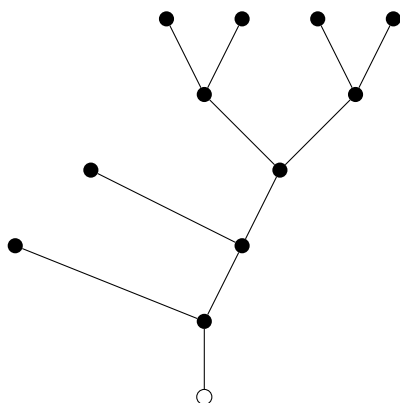
19.18.



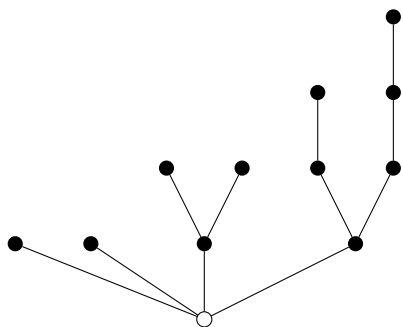
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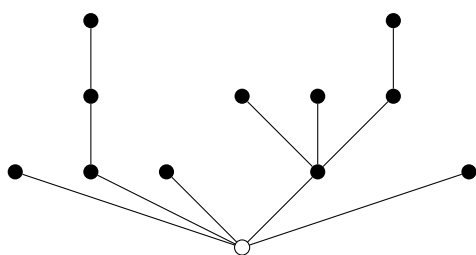
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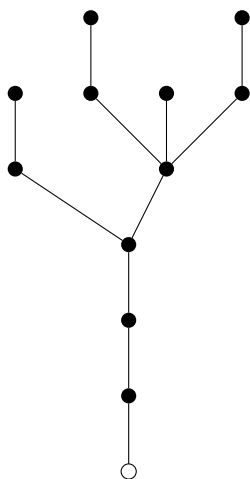
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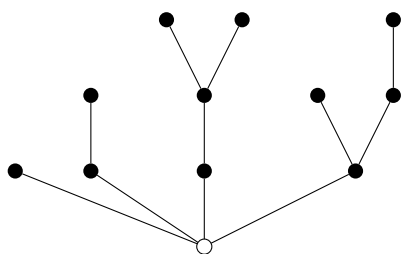
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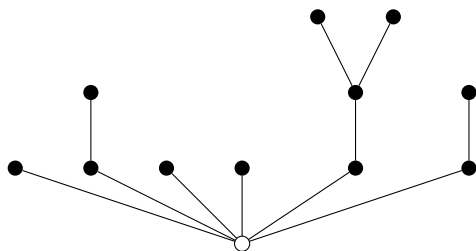
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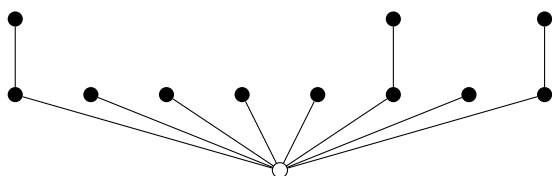
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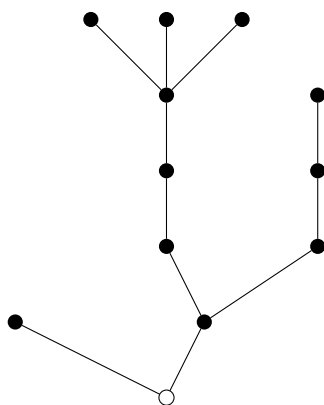
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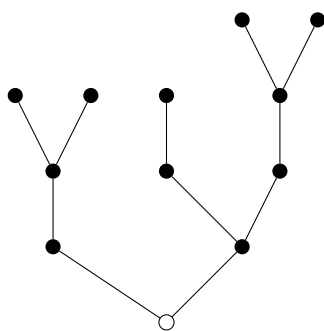
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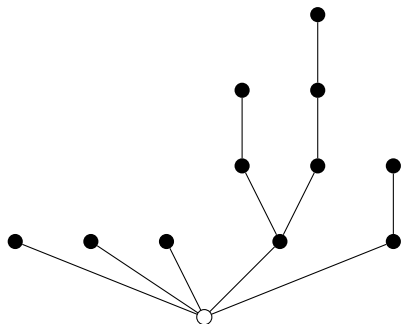
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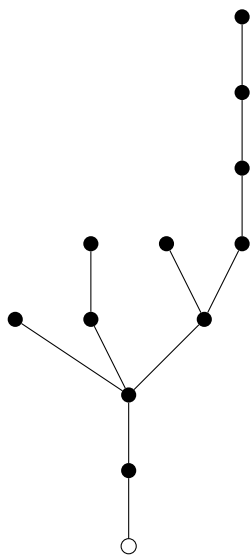
19.28.



19.29.

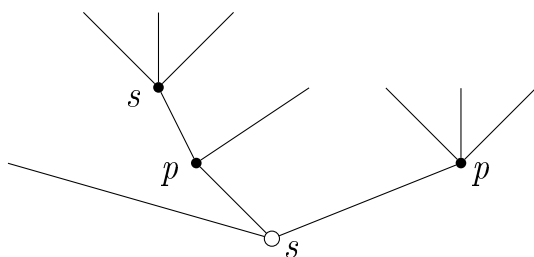


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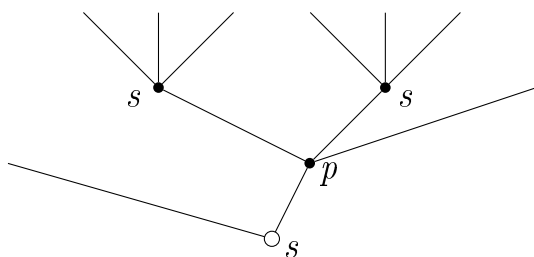


20. По диаграмме расщепления восстановить  $\pi$ -сеть.

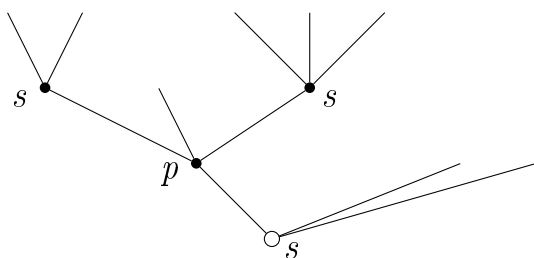
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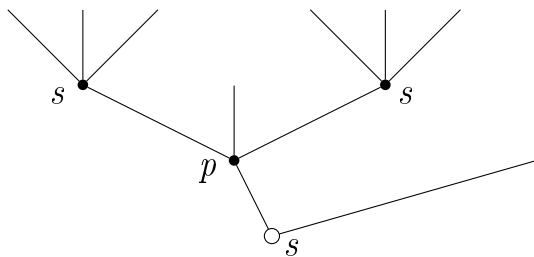
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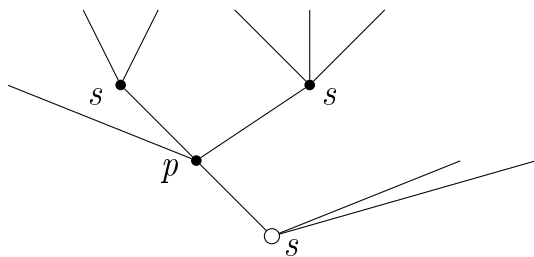
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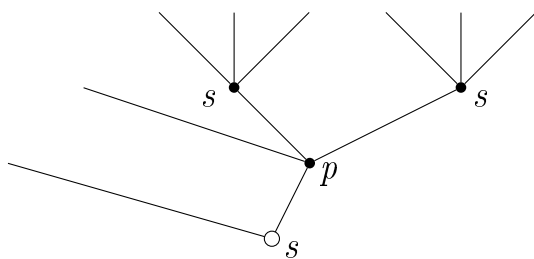
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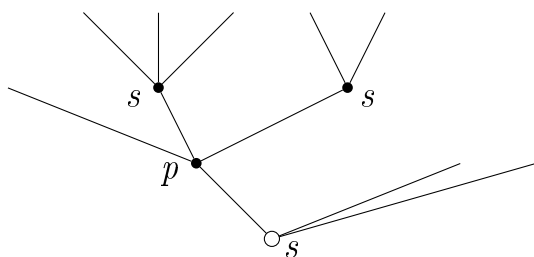
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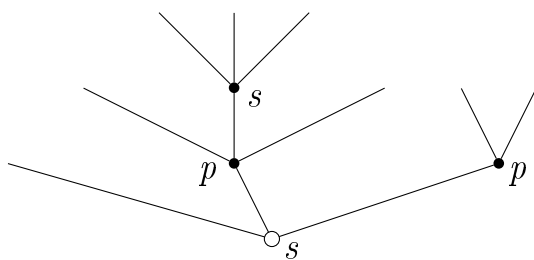
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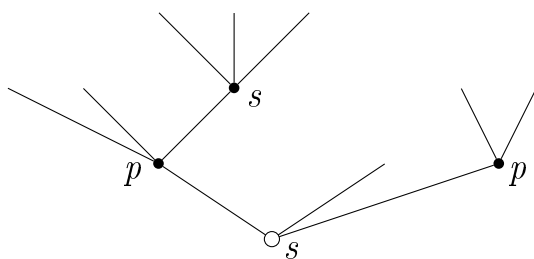
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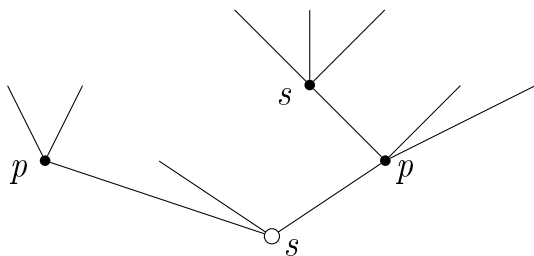
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20.9.

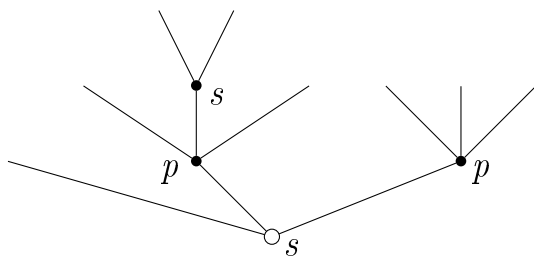


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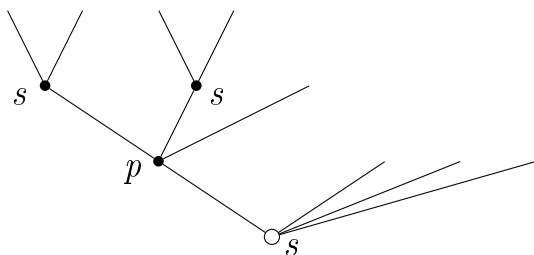




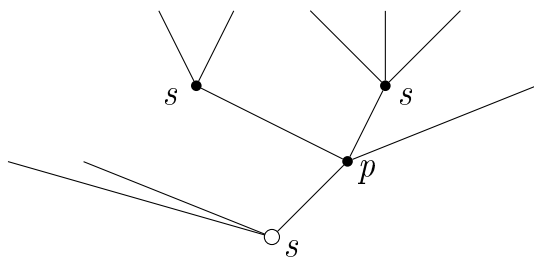
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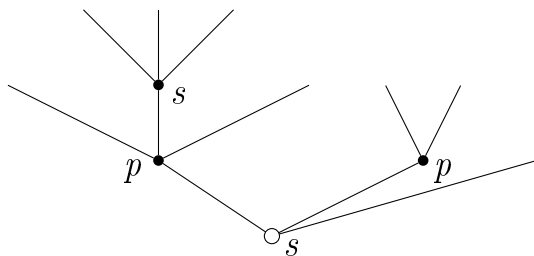
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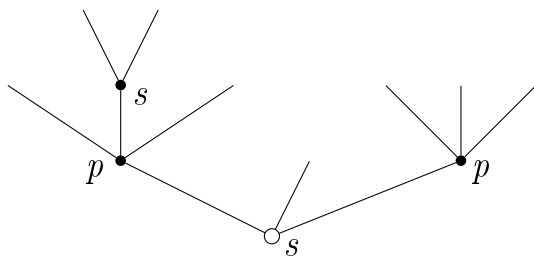
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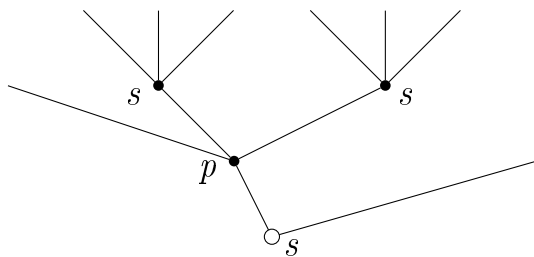
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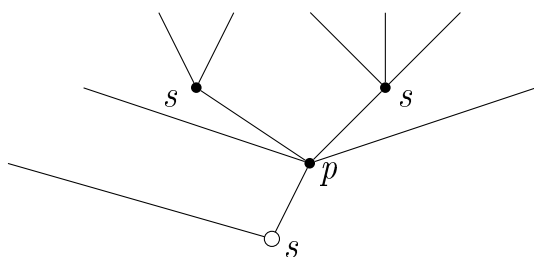
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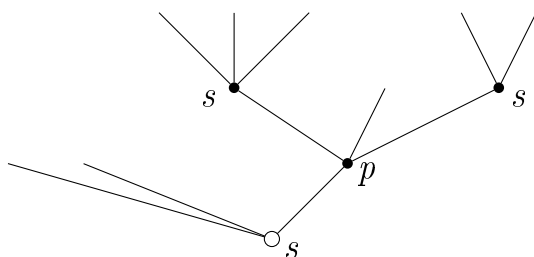
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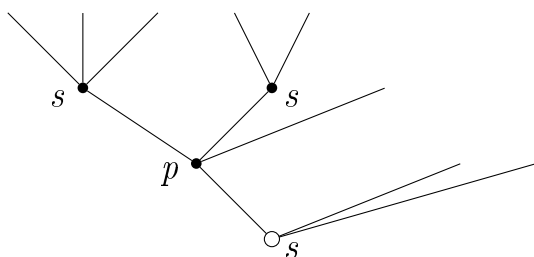
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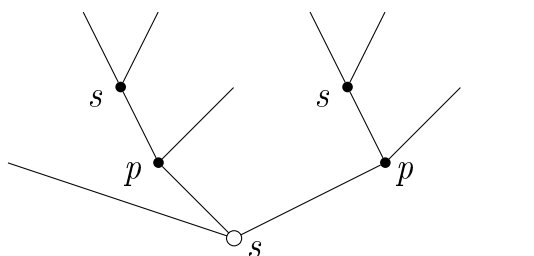
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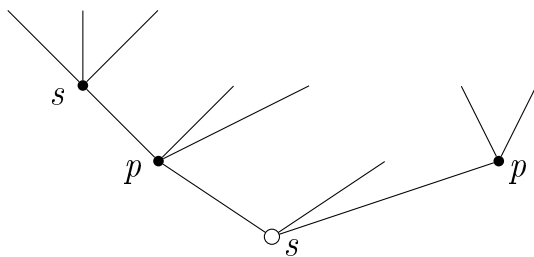
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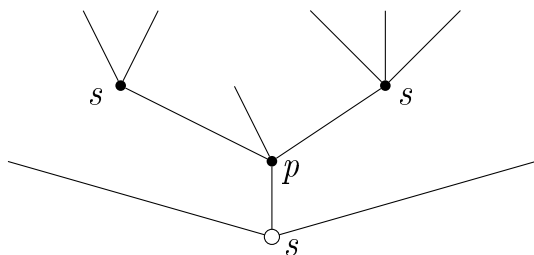
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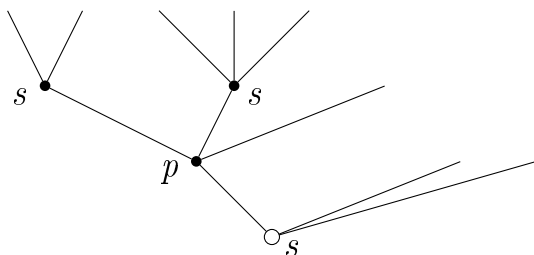
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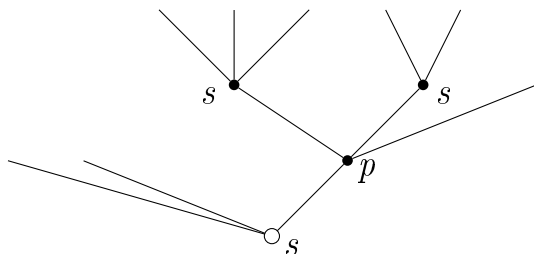
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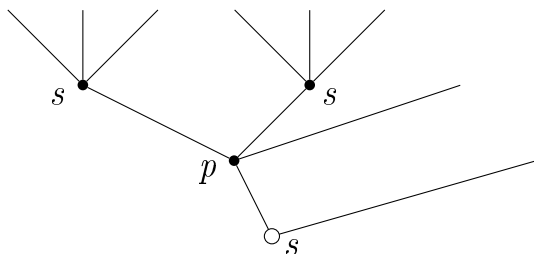
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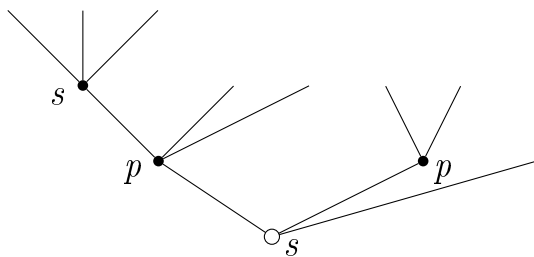
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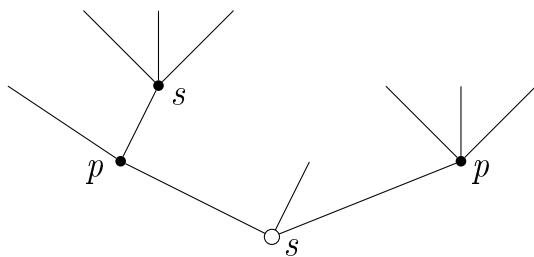
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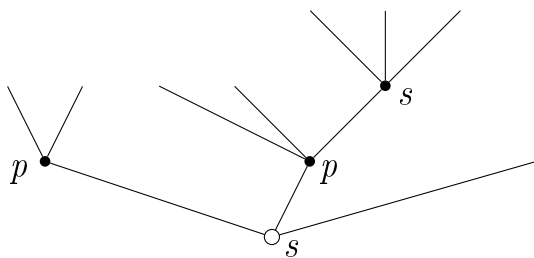
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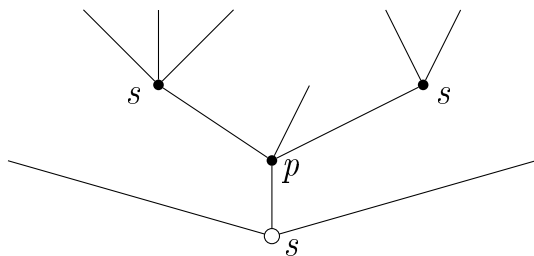
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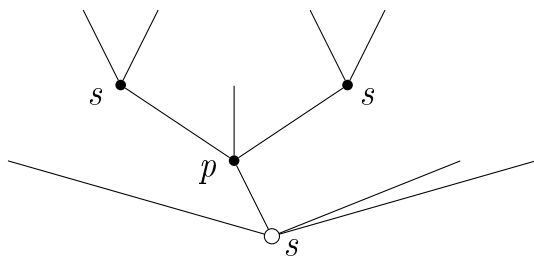
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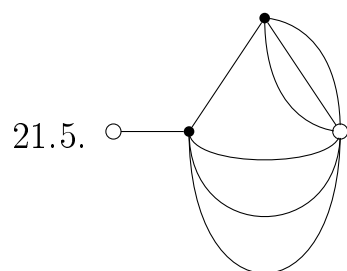
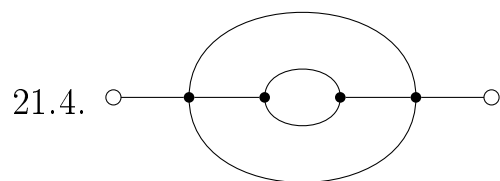
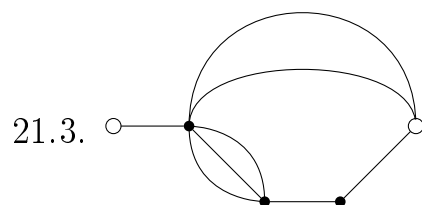
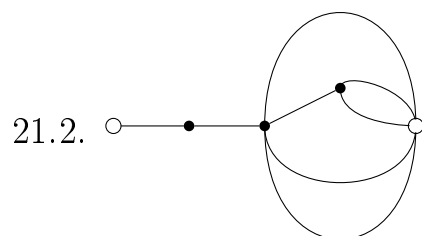
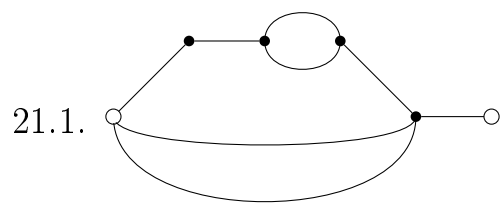
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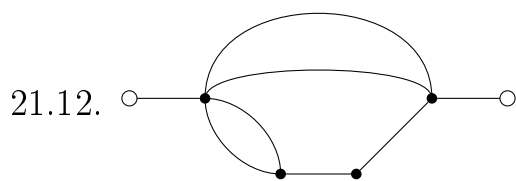
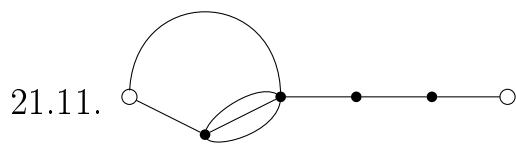
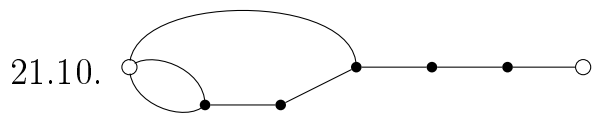
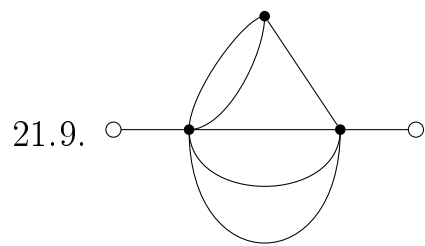
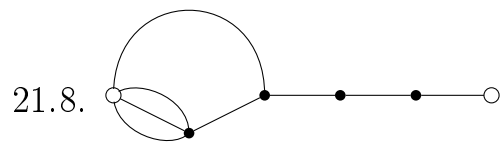
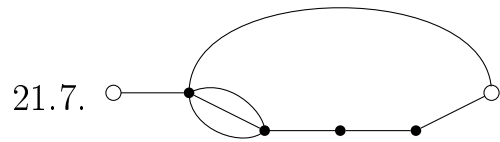
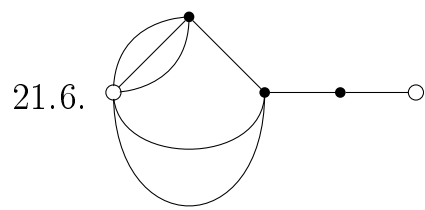


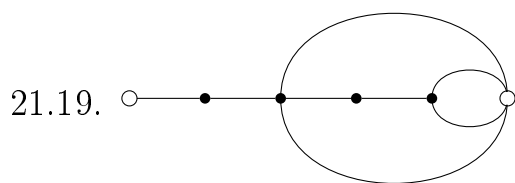
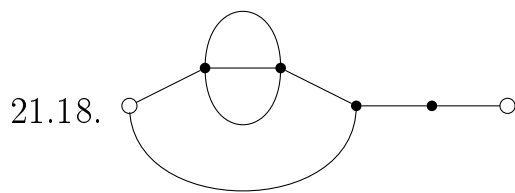
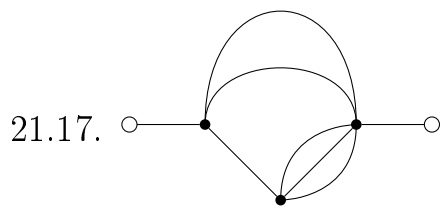
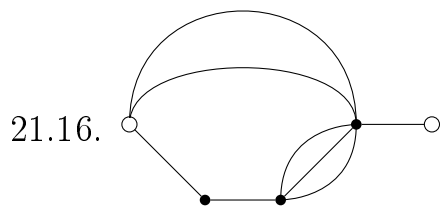
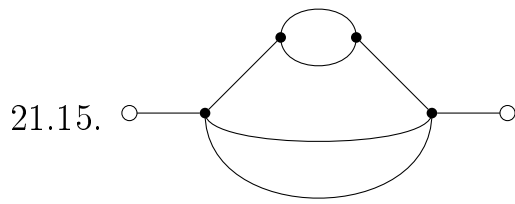
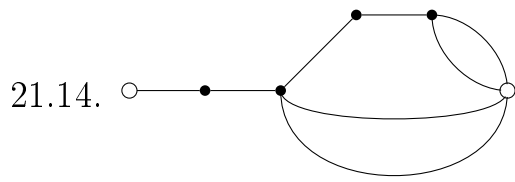
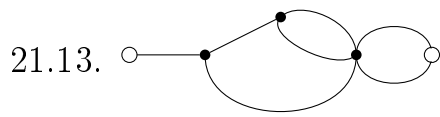
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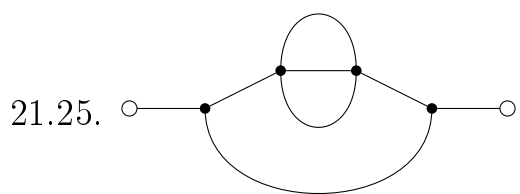
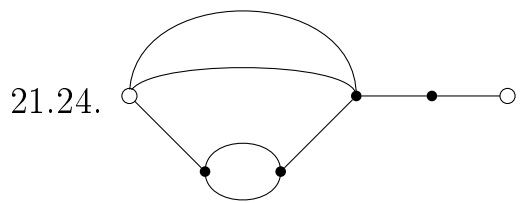
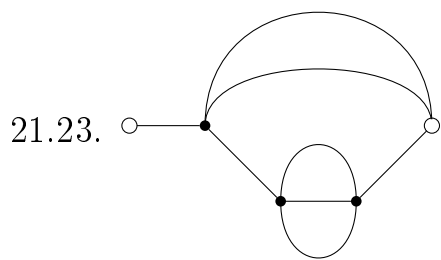
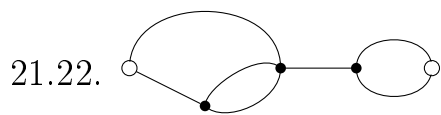
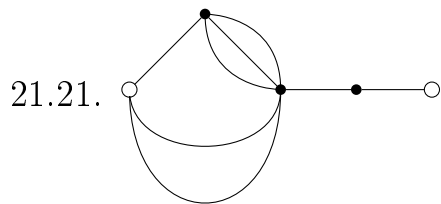
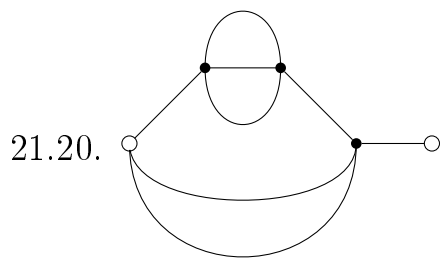


21. Для  $\pi$ -сети построить диаграмму расщепления.

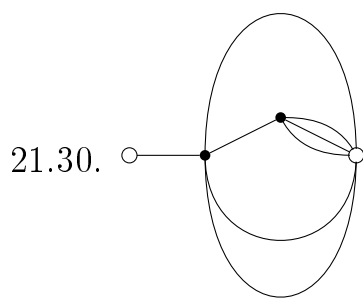
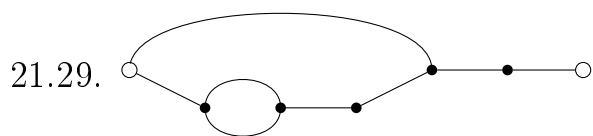
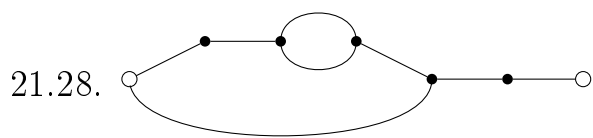
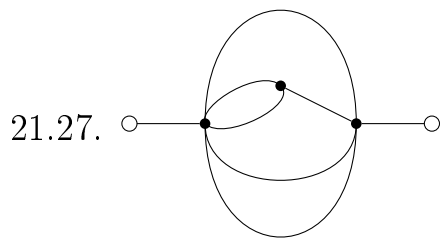
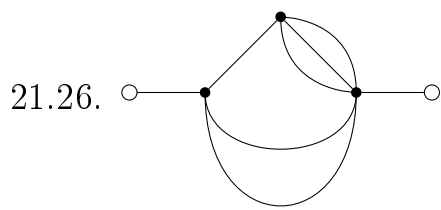












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